AUGUST
1969

45¢

Live Steam

THE MONTHLY MAGAZINE FOR ALL LIVE STEAMERS AND LARGE-SCALE MODEL RAILROADERS

A Pair of ROYAL HUDSONS

Young Valve Gear

Live Steam
magazine

AUGUST 1969 VOL. 3 NO. 8

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COVER PHOTO

Walter Johnston and his 1½" scale Hudson at the coaling tower of the Johnston Lines in Northwest Indiana as the Mid-South Live Steamers meet for a day of running on his track. Photos by David M. Boyd.

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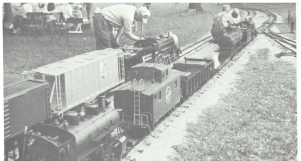

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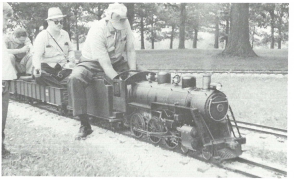
Mid-South Live Steamers

2

PHOTOS
1, 3, 5, 6, 7 BY WM. C. FITT
2, 4, COVER BY D. M. BOYD



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Visit In Hoosierland

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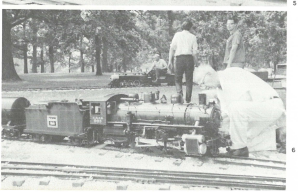

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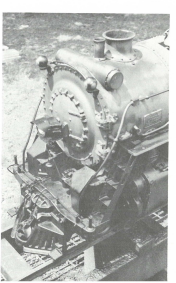
Mid-South Live Steamers ventured north for a fine day of running at the invitation of Mr. and Mrs. Walter Johnston on July 26th and the 2550 foot track of the Johnston Lines saw plenty of activity.

Host Walter Johnston (cover) sidetracked his 1½" Hudson to provide plenty of opportunity for running (1 *l* to *r*) P. R. "Bud" Bartholemew's 4–6–0, Austin Barr's 4–6–2 and Lynn Lowe's 0–6–0 and provided rolling stock to make up adequate trains.

While Lynn Lowe (2) takes on water at the tank, Bud Bartholemew (3) gets ready to take off down the main line with a load of passengers. Austin Barr (4, *t*) makes final connections to the tender while getting up steam. Basically a Little Engines Pacific (with Austin's personal attention to specific details), Ray Pieper (5) finds that it runs fully as good as it looks. Dick Lippens (6), who built the CB&Q switcher now owned by Lynn Lowe, makes adjustment on the engine.

For 29 years, signalmen along the New York Central tracks were privileged to this view (7) out of a tower window. Now, thanks to craftsman Walter Johnston's finely detailed NYC Hudson, only a very little imagination is required to relive the thrill of seeing those full-size engines roll by.

After a full day of running, the Johnston's treated the out-of-town Live Steamers to a fine dinner and a wonderful evening of movies, sounds of steam and conversation. Truly a day to remember.



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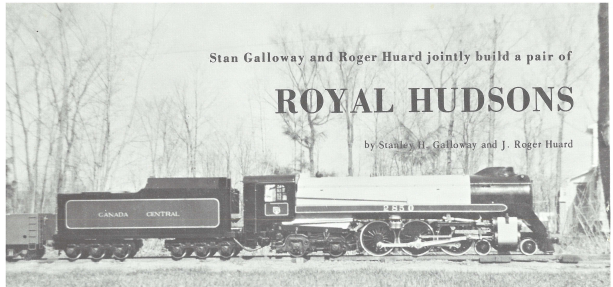
Stan Galloway and Roger Huard jointly build a pair of

ROYAL HUDSONS

by Stanley H. Galloway and J. Roger Huard



STANLEY H. GALLOWAY

Did you ever stop and think back on how you got started in this fascinating hobby, or how you happened to make friends in a club? This is the story of how two strangers got together and eventually built two engines, substantially alike.

In 1950 Stan Galloway was transferred to Montreal (by the Navy), and knowing there was a Live Steam Club there, began a search to find it. He had no success until one day he read an advertisement in "Railroad Magazine" wherein Roger Huard was offering for sale a ¾" steamer. A telephone call revealed that the engine had been sold, but that didn't matter – the main point was that Stan had found his club and Roger was to acquire a new friend. These two fellows enjoyed many an evening discussing live steam subjects and engines. They also spent quite a few Sunday afternoons running Roger's engine on a track at his Summer cottage.

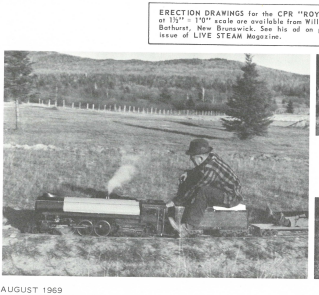
Neither one knew what was coming, but by the Fall of 1951, the stage was set, the bug had bitten (or however you want to express it!), to trap these two into a project that would go on for years. Each one tripped over his own "problems" but they both fell into the same place each time. Rog had acquired his engine by trading in an unfinished chassis for the ¾" steamer, but hankered for an engine that he could say he built himself. No reflection on the engine he owned; it operated week after week without the slightest bit of trouble. In fact, he wore out a set of side rod bushings because some weeks he actually ran the engine twice! Now Stan, on the other hand, had just finished his first engine and with the coming of cold weather there would be no more operating for a while. Thus, when Rog announced he was planning on building a 1" scale Hudson, and had already made some drawings, Stan offered to check over the drawings in his spare time.

The drawings for a 1" engine, including the tender, are lengthy and it isn't always possible to lay your hands on a piece of paper 8 feet long in the average household. So Rog made his sketches on the back of some wallpaper (unused, of course). Stan was working in a drawing office at the time, so what would be more natural than to bring home a length of tracing paper and transfer the designs so that prints could be made in the future? That's what happened and that's when the trap snapped! Neither man knew he had been caught and so they both went along blissfully unaware of their predicament and enjoying themselves as they finished the designs and actually made the odd pattern. After all, it didn't cost anything to make the patterns because everybody has some wood laying about in his shop. It does give a certain sense of accomplishment to figure out the way and then make the pattern. Of course, there are certain temptations involved in living this way. The presence of a foundry just two blocks out of his way to and from work didn't help Stan any either. Well, you know what happened – they just had to try out those patterns. Naturally, Stan figured as he had helped in the work he might as well have a set of castings while he was at it. By January, 1952 they had 5 drivers with small counterweights, 2 with large weights, 4 trailer truck sides, 3 spoked wheels for the trailer truck, 4 engine truck wheels, 2 cylinders (at 10 pounds) and 2 cylinder bushings at a total cost (hang onto your hats) of $17.29! And that's the truth, too! Rog still has the

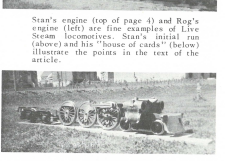
Builders:	Stanley H. Galloway Beaurepaire, Quebec	J. Roger Huard Quebec, P. Q.	
Dates:	Started: 1951 Under Steam: 1956 Completed: 1958	1951+ 1963	
Type:	4–6–4 "Hudson"		
Scale:	1 : 1/16" = 1'0"		
Gauge:	4¾"		
Prototype:	CPR "Royal Hudson", (MLW 1938)		
Cylinders:	Bore: 2½" Stroke: 2¾" 2 rings per piston, 1/8 x 1/8 x 2"		
Valves:	Piston, 1" dia. x 21/32" travel; lap 1/8", 72% maximum cutoff; no rings on Galloway's engine, rings on Huard's engine.		
Valve Gear:	Walschaerts – screw reversing on Galloway's, Johnson bar on Huard's.		
Boiler:	Copper, 1/8 wall, all brazed, weight 124#		
	Pressure: Galloway's – 900 psi Huard's – 1100 psi		
	No steam dome		
	Tubes: 22 copper ¾" o.d. 23" long		
	Capacity to ½ gauge glass: 11 Imperial quarts.		
	Fuel: Coal		
	Grates: 7 x 11 inches (77 sq. in.)		
	Safety Valves: 3		
	Hydraulic test when first completed: 280# psi		
	Throttle: Front end, no superheater		
Weights (Galloway's)	Engine (light): 343#		
	Tender (light): 85#		
	Engine and tender: 428#		

Tender capacity:	5 Imperial gallons to 90% full
Equipment:	Brakes: Steam on drivers of both engines, also on trailing truck wheels on Galloway's
	Tarrington needle bearings on driver axles. All other axles run in cast iron bushes or castings.
	Whistle
	Injector
	Axle pumps: 2 rams of ¾ dia. x ¾ stroke, single acting.
	Steam-driven feed water pump
	Shifter valves on valve chests
	Tender trucks cast in one piece
	Booster Engine (Galloway's): 2 cylinder, 11/16 bore x ¾ stroke, gear ratio 3:1
	Staker Engine (Galloway's): 2 cylinder, 11/16 bore x ¾ stroke; auger 7/8" dia.
	Cylinder Cocks: Cab-operated mechanically on Galloway's; hand operated on Huard's
Tractive Effort:	With the Montreal Live Steamers' Dynamometer car, Galloway's engine registered 40–43# maximum, at which point the drivers slipped.
	Calculated: Galloway's engine – 141.61#
	Galloway's booster – 14.367#
	Total – 155.978#
	Huard's engine – 173.080#
Indicated Horse Power:	Galloway's engine – 1.495
	Huard's engine – 1.828

ERECTION DRAWINGS for the CPR "ROYAL HUDSONS" at 1½" – 1'0" scale are available from William Dykeman in Bathurst, New Brunswick. See his ad on page 14 of this issue of LIVE STEAM Magazine.



Stan's engine (top of page 4) and Rog's engine (left) are fine examples of Live Steam locomotives. Stan's initial run (above) and his "house of cards" (below) illustrate the points in the text of the article.



foundry receipts. Stan was doing all right too – he recalls wheels at 40¢ each and other things in proportion.

Well, a little success is hard to argue with. There was Rog with some pieces of cast iron, his lathe, the drawings, etc., and winter was still with them. When Rog machined his wheels, it was just too convenient to do Stan's castings with the same set-up. In return, Stan figured he could assemble the two engine trucks. Naturally, the desire to see whether all the pieces would fit together, or not wasn't exactly troubling him back. There were setbacks too, that came along unexpectedly. Rog knew someone in a plant where the frames could be flame-cut out of boiler steel on a pantograph machine. He also had a friend with a big machine shop where the important parts such as the pedestal openings could be cleaned up on a miller. Progress was really fast at that point, until they received the bill. There were two long faces that night and a deathly hush. Neither wanted to take home the frames, as who can carry in four pieces of steel, each about 36" long, without being asked, "How much did THAT STUFF cost?"

By Spring, they had all the major pieces ready to build the chassis. The frames were assembled and the cylinders machined. There's a story on them attached to this article – one is a house of cards really, as all the pieces are just leaning against each other, partially assembled. Looking back on it, both men agreed it was a good winter's work. Each felt, too, that he could still take or leave the project of the 1" engine – little did they know what the future held in store for them!

Plans, drawings, data, etc., continued to pile up during 1952. It wasn't exactly a surprise, but in late Summer Stan was transferred to Halifax and in March, 1953, Roger went to Quebec City to take charge of an office there. So the two were separated geographically, but not as friends. Production stopped though, as Stan was at sea and Rog had to build himself a house. It wasn't until 1954 that things really began to move again.

By that time, Roger was looking for property for a Summer place and the hilly country indicated that the 1" engine was going to have a tough time with the grades. On the other hand, Stan became acquainted with a certain fellow from Ottawa on his Summer training, who had connections with a government experimental foundry. Well, Navy men have a way of cooperating with each other, and when Stan was moved again, this time to Ottawa, who will be surprised to hear that more castings began to appear on the scene?

And then again we have the strange coincidence of both Stan and Rog becoming involved with the same pressures at the same time. Rog finally selected geometry and found he definitely couldn't get along with the ¾" scale. Stan found himself with a large pile of pieces and one day said to himself, "Either I get rid of this stuff or finish the job." This is when both men found out they were really hooked – neither could or would abandon the project. However, the separation was beginning to have some effect. They rarely saw each other although they wrote at intervals and thus differences began to appear in the two engines. After all, they were no longer able to share the machine work. The benefits for patterns and drawings still went on, of course. The accompanying pictures will show the minor differences that appeared.

Although each was now determined to finish his engine, both ran into difficulties. With the chassis finished and ready to start on the boiler, Stan slipped a disc and heavy lifting was no longer possible. One way around this was to have the boiler built in England, which solved the technical problem, but which also gave rise to a financial problem. This was eventually solved after negotiations with his wife, who wanted a new fur coat. Let all married men take note at this point that one fur coat does NOT equal one boiler! You'll get taken on this deal, so don't leave this magazine lying around unless you are in desperate straits!

On the other hand, Roger's difficulties were more serious and more prolonged. First, he had heart trouble that put him out of action for a long time, and later a second attack put him on notice for standing. The result of this was that Stan's engine was finished first and began to operate in his backyard at Ottawa in 1956. There's a picture of the first run – so impatient was he to see it go that he used a bucket to hold water in lieu of the missing tender tank. Ever since, Stan has claimed that Rog conned him into building that engine, but if the record is known he's late much arguing on Roger's part. It makes a good story, though, for certain ears.

While this was going on, Roger was gradually overcoming his troubles. In a few years he regained his health, built that cottage and started a small flower business as a side line. Not much progress on the engine, but then you wouldn't say that he had been exactly idle either! Eventually the time came when he decided that he needed that engine. With all these things going on, he too had to call on outside help with finishing the engine. A mutual friend, Jim Trumbull, did the finishing touches and a firm of Montreal coppersmiths made the boiler. Roger also ran into the same trap when he decided to have the boiler made. Two dollars worth of fur coat for each dollars worth of boiler was the "fine." The boys may have the last laugh yet, though, as it looks like the boilers will outlast the fur coats. So, in 1963 Roger was in operation too. In these days of dwindling passenger travel, Roger wanted to ensure that his railroad would always have business so he increased his family from two to six children!

About this time other changes were taking place. Stan was now out of the Navy and had gone to work in Montreal. Rog makes a living business in that city so they still get together almost once a month. When viewing each other's movies it's quite hard to tell the two engines apart. General design and paint schemes are alike, of course, and both engines use mechanical lubricators, axle pumps, injector and screw-type reverse gear. Both have steam feed water pumps but Roger's is under the cab deck while Stan's is on the left side under the running board. Various other differences have crept in: Stan fitted a working booster engine and brakes on the trailing truck and has put a stoker with the drive engine in the tender.

The construction work did not stop with the completion of the engines. One conversation led to another and patterns, etc., were made for cars and each now has a sizable fleet of both passenger and freight cars. Roger's 1" scale engine is having a hard time of it on the grades and he's thinking of something bigger . . . say 1½" scale. Stan works in the Canadian National Headquarters and has made contacts in the plans section of the Chief of Motive Power's office. So guess what? Stan is advocating the construction of a 4–8–4 in 1½" scale and Roger is saying, "Now who's being conned into what?"

Two men are wondering "where does this thing end?" Two wives are asking, "WHEN does this thing end?"

Who knows though, when those fur coats are worn out the ladies might even get around to suggesting that a new engine is almost a necessity, what with the kids growing up so big and all!

GEORGE J. ATCHISON

The Steam Railroad Restoration Society acquires a

Steam-Powered Wrecking Crane

by George J. Atchison

A steam-powered railroad wrecking crane capable of lifting 120 tons has been added to the growing museum of steam-era railroad equipment being collected by the Steam Railroad Restoration Society and displayed on track leased from the steam-powered Cadillac & Lake City Railway at Lake City, Michigan.

The wrecking crane, or "big hook" as it is called in railroad terms, along with its boom car and tender was donated to the Steam Railroad Restoration Society by the Detroit, Toledo and Ironton Railroad. Individual members of the Society contributed the funds to pay for moving the three pieces of wrecking train equipment from Springfield, Ohio, to Lake City.

The crane was built in 1919 by the Industrial Works of Bay City, Michigan (now the industrial Brownhoist Division of American Hoist and Derrick Co.) and bears shop number 3874. For the past 50 years it has served as the main item of wreck-clearing equipment at the Springfield terminal of the DT&I but was recently displaced by a new and more powerful Diesel-powered unit. It moved from Springfield to Lake City via the DT&I, Ann Arbor, Penn Central and the C&LC Railroads.

The crane consists of a cab unit mounted on a massive steel car body. The cab is arranged so it can rotate around the mid-point of the car body. One end of the cab supports a 35 foot, heavy steel boom from which the hoisting "big hook" is suspended by a system of large pulleys and a one inch diameter steel cable. An upright steam boiler with its water supply tank and coal bunker is located at the opposite end of the cab. The space between the boom support and boiler is completely filled with two 12" x 12" double-acting steam engines and the heavy gears, clutches, hoisting drums and brake apparatus used to raise and lower the boom and the hoisting hook. These operations can be carried out independently and are controlled by the crane operator who operates the steam engines and fires the steam boiler.

The heavy boom, which extends beyond the car body for 28 feet, presents a problem when it is necessary to move a crane in a train. This is solved by placing an idler car or boom car next to the crane. The boom car is a curious hybrid which is half caboose and half flat car. It provides living accommodations for the crane crew in the caboose portion when the crane is away from home terminal and storage space on the flat car section (under the overhanging boom) for the many pieces of heavy blocking timbers and tools necessary for the operation of the equipment.

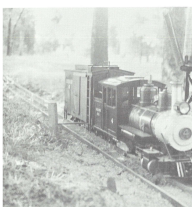
A steam crane's duties were not always in the wake of a rail disaster. Its brawn was many times applied to the mundane chores of moving heavy machinery and occasionally to trackside construction work such as moving heavy bridge sections.

The *Steam Railroad Restoration Society* is a non-profit corporation chartered by the State of Michigan and authorized to procure, preserve, restore, exhibit and operate steam-era railroad equipment for educational and museum purposes.

Future plans of the *Steam Railroad Restoration Society* include the renovation of the crane to working order so it can periodically be fired up to demonstrate how such steam-powered equipment operates. Mr. Carlton Johnson of Lake City is acting as supervisor of the restoration work. He has extensive experience in restoring steam traction engines and steam locomotives, including his personal 50-ton 0-4-0T steam locomotive.

BIG DAY FOR CINDER SNIFFERS

by Robert W. Maynard



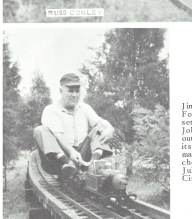
RUSS CONLEY

The 12th annual Cinder Sniffer Picnic on July 4th literally went off with a "BANG!" The air was punctuated with salvos from Lew Bower's model of a Napoleon 12 lb. field piece and Rip Collin's creation of an eighteen pounder Naval gun.

A total of more than 150 friends, relatives and club members enjoyed the festivities along with the first operation on the partially completed track. There were three ¾" scale engines under steam – Lew Bower's *Thom Thumb*, John Korte's 0–4–0 *Juliet* and Bob Maynard's 4–4–2 *Evelyn*. Jim Aull's 1½" scale two-footer for 3½" gauge track blew a cylinder head gasket and was placed on display with Joe Maupin's almost-complete 1½" scale *Tich*.

The mileage indicator on the 4–4–2 *Evelyn* recorded over seven miles for the afternoon's operation although the total length of track was only slightly more than 500 feet.

It was interesting to note that in spite of the swing to the larger scale, the steam operations were confined to the 3½" gauge. We devotees of the small sizes may take some heart from this!



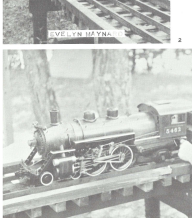
EVELYN MAYNARD

1

Jim Aull's 1½" scale Two-Footer operates in realistic setting (1) on 3½" gauge track. John Korte's "Juliet" rumbles out across the trestle (2) with its builder in tow. Bob Maynard makes last minute equipment check (3) and readies for the July 4th run at the Cincinnati Cinder Sniffers picnic.

2

3



RUSS CONLEY

LAKE SHORE LIVE

After meeting occasionally for several years, a group of Live Steamers in the Greater Cleveland area have made the move and formed into the Lake Shore Live Steamers. They now meet regularly on the third Friday of each month at various members' homes but have no officers or dues. Bruce Blackman serves as Secretary and anyone interested in meeting with them can contact him at 8125 Sweetbriar, Mentor, Ohio 44060.

Activity within the group covers all scales and types of Live Steam. Clyde and Chan Bleil (father and son, Mentor, Ohio) have a Little Engines Atlantic and a two-truck Shay operating on 750 feet of 7½" track; Bruce Blackman (Mentor) has a ¾" scale 2–4–2 operating and a 1½" B & O 2–8–0 nearing completion; Snub Pollard (Lorain) has a ¾" scale 0–6–0 and a 1" 4–4–2 operating, and a 1" *J. W. Bruker* under construction; Bud Pickard (Willoughby Hills) is building a 1" Pacific; Roy

Scheduled Meets

October

4 LOS ANGELES LIVE STEAMERS
Annual Fall Meet
3½"—3¾"—5"
Joel Carlson, Secretary
12733 Kittridge Street
North Hollywood, Calif. 91606

11 PIONEER VALLEY LIVE
12 STEAMERS
13 3½"—4¾"—7½"
Ralph Green, Secretary
3 Fleetwood Drive
Sandy Hook, Conn. 06482

11 SOUTHERN MINNESOTA
12 LIVE STEAMERS
3½"—4¾" gauge
Dr. Richard Hinkle, Lake City
Richard M. Hinkle, President
220 First Ave., S. W.
Rochester, Minn. 55901

Regular Run Days

GOLDEN GATE LIVE STEAMERS
Every Sunday, weather permitting
2½"—3"—4½"—7½"
Maynard Colchin, Secretary
614 18th Avenue
Menlo Park, Calif. 94025
Phone 415 – 325-4309

JAMUL VALLEY RAILROAD
3rd Sunday each month
7½" gauge
Route 1, Box 1
Rhoads Mountain
Jamul, California 92035

NEW JERSEY LIVE STEAMERS
Each Sunday, May thru October
3½"—4¾"—7½"
Ralph Green, Secretary
3 Fleetwood Drive
Ellisdale, N. J. 07208
Phone 201 – 353-6424

PIONEER VALLEY LIVE STEAMERS
2nd Sunday each month
3½"—4¾"—7½"
Everson W. Burnfather, Secretary
3 Fleetwood Drive
Sandy Hook, Conn. 06482

NEW STEAM AT TRI-STATE MEET

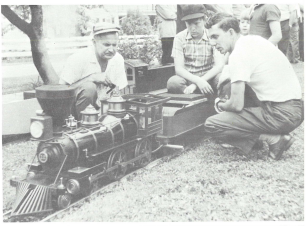
PHOTOS BY WILLIAM C. FITT

Rain-soaked ground and heavily clouded skies dampened the spirits of Live Steamers headed for Jack Spalding's track near Monroe, Michigan, on July 19th but the weatherman held off any more downpours until late afternoon when the running was finished.

About fifty Live Steamers from Ontario, Ohio, Indiana and Michigan had a good opportunity to talk steam and, during a business meeting, voted to change the name of the club from the Michigan Steam Locomotive Club to the Tri-State Locomotive Club. Attendance has always been bolstered by out-of-state Live Steamers and the change acknowledged that fact.

All equipment was 1½" scale with Host Jack Spalding's Hudson running the whole day. Frank Stewart kept up the pace with the 4-4-2 that he built for Harry Pertner and Paul Fitt's diesel held the siding.

Most attention, though, centered on two new engines — Fred Hanson's 4-4-0 (which looks more and more complete each time it shows up at a meet) and John Pugh's new Hudson which is going to be one to listen to. Exhaust sounds like that haven't been heard in Monroe since the *Mercury* stopped running!



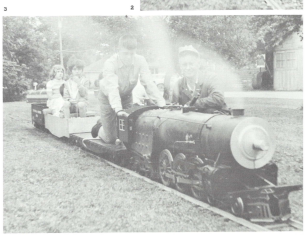
1

STEAMERS FORMED

Johnston (Walton Hills) is working on a ¾" 4-8-4; Lou Giess (Walton Hills) looks forward to completion of his 1½" 2-6-0 and Larry Palmer (East Lake) has his ¾" *Royal Scot* finished. Robert Gould (Wickliffe) has stationary steam engines that he has built and Joe Clapsadl (Painesville) has a full-size Frick traction engine of about 1895 with wood spoke wheels. Robert Christman (Erie, Pa.) has steam cylinders finished for his 1½" NYC H-10 Mike which now operates with a gasoline motor but will operate on steam soon and Robert Graham (Erie) operates a gasoline powered fluid drive Budd Rail Car on 2,000 feet of 7½" gauge curves, grades, bridges, cross overs and figure eights! Contact Bruce Blackman at the address above for further information if you would like to join in with these Live Steamers!

Fred Hanson's new 4-4-0 (1) builds up steam while Fred, Russell Williams and Fred Evans (l to r) look on with rapt attention. Dick Due (2) looks satisfied that the running gear of his Little Engines 4-4-0 is making its test adequately as it is towed around the track. Paul Fitt eases out the throttle (3) on John Pugh's new Hudson as John kneels alongside the cab, waiting for that first deep exhaust.

2



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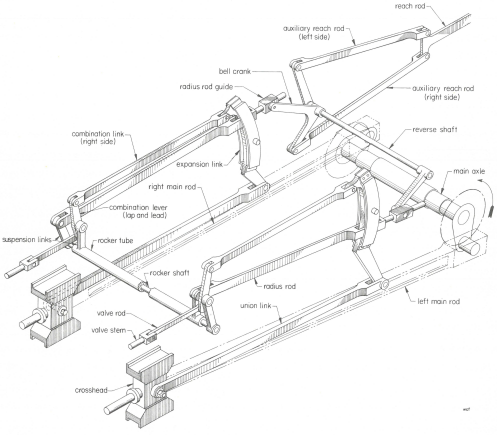


YOUNG VALVE GEAR

VALVE GEAR

SO YOU WANT TO BUILD A LIVE STEAM LOCOMOTIVE

by Joseph F. Nelson

CHAPTER 10

YOUNG VALVE MOTION

This valve motion is a combination of two principles: (1) The Walschaerts principle with the lap and lead lever, radius rod, and trunion mounted expansion link, and (2) The Stevart principle which is basically the Walschaerts principle without eccentrics. The cross-head-driven expansion links on one side controls the cut-off on the other side.

Stevart was a Belgian engineer who originally developed this motion in 1871. The Stevart motion was used in various forms by Churchward and Deeley in England and by Belpaire (of firebox fame) in Belgium, Holland and France. These European motions were mounted between the frames and, in some cases, were used on 4-cylinder engines.

O. W. Young of Chicago developed the valve gear that bears his name at the turn of the century. Since its expansion links were driven by the crosshead and not an eccentric, the Young valve gear can be classed as a Stevart. While the other valve gears drive their lap and lead levers from the crosshead, the Young has inverted lap and lead levers which are driven from the top of the expansion links. This principle of driving the expansion link from the crosshead tends to eliminate errors that do creep in from an eccentric rod being driven by a crank or an eccentric. However, this motion does have the disadvantage common to the Stevart motions, in that the locomotive is rendered completely incapacitated in the event of a broken main rod.

The reach rod is divided into two auxiliary reach rods; one connected to the bell crank on the right side, and the other connected to the reverse shaft to the left side. It is to be noted that this causes the radius rods to move in opposite directions: one moves up while the other moves down, and vice-versa. The expansion links are driven by the crossheads through long link rods. As already mentioned, the lap and lead function is taken care of by inverted lap and lead levers driven by combination links connected to the top of the expansion links. Up to this point, everything has been driven by the crosshead on its same side. In order to get the 90° difference of motion between the lap and lead function and the valve opening function, it is necessary to cross over to the other side of the engine and take the timing of the other crosshead. This obtains the expansion link function from the opposite side of the engine.

This crossover of motion is accomplished through the use of a coaxial rocker shaft-tube with suspension links on both ends of each. The suspension link driven by the radius rod on the right side drives the suspension link supporting the lap and lead lever on the left side. Conversely, the suspension link driven by the left side radius rod drives the right suspension link supporting the right side lap and lead lever. Since the cross drives are coaxial, one side drives the other side by shaft, and the other side drives in the opposite direction through a tube surrounding the shaft.

In reviewing the peculiarities of the Young valve motion, we have the following:

1. The radius rods move in opposite directions.
2. The radius rods are not supported by hangers, but by guides.
3. The lap and lead levers are inverted.
4. For inside steam, the conventional way is to connect the radius rod to the upper end of the lap and lead lever. But for the inside steam Young, the lap and lead lever is connected to the radius rod through the suspension where the radius rod normally connects for outside steam.

It is felt that the lap and lead lever being driven from the expansion link instead of directly from the crosshead, was the desire on the part of Young to be different. It is to be noted that the Churchward-Stevart, Deeley, and Belpaire motions had conventional lap and lead levers driven from the crossheads.

Radius rod hangers cannot be used with this motion because since they swing in an arc, this gives a different pattern of movement in the upper half of the expansion link than in the lower half. The radius rods must be supported on their ends by guides instead of swinging links or hangers so that the radius rods in opposite ends of the expansion link will receive equal movement.

The Young valve gear never attained any great popularity although it was installed on Union Pacific 4–8–2 and 2–10–2 locomotives, the Chicago and Northwestern used it on 100 or so of their engines and the Canadian National applied it to many types of motive power including 0–8–0, 2–8–0, 2–8–2, 4–6–0 and 4–6–2.

FILING for the apprentice

by Jack D. McKenty, M.D.

Filing is an art which is learned by lots and lots of practice. Except for model engineers, it is becoming a lost art. Many modern machinists will spend an hour setting up a job in a milling machine, when it could be done in fifteen minutes with a file.

Of the utmost importance is the vise. The kinds with a vacuum cup bottom, on a little screw clamp for fastening to the edge of the table, are mere toys, and should not be considered. The vise should be a big one, with some heft to it, and it should be bolted firmly to the corner of the workbench. The jaws should overhang the front of the bench so that long work pieces can be held vertically.

The top of the vise should be at the level of the elbow; it can be higher for delicate work, or lower for heavy filing. The serrations in the jaws may mar the work, but jaws without teeth are hard to get. If you know someone with a surface grinder, the jaws may be removed and the teeth ground off. Or you could replace the jaws with new ones home made of smooth brass. (Replace them at regular intervals.) Or you could use "clams" over the jaws; fittings of lead, copper or plastic which clamp over the jaws and present a smooth surface to the work. Plastic clams are available at hardware stores. These also must be replaced at intervals.

To file, stand facing the vise with your left foot forward. (If you are a south-paw, reverse the instructions.) The right hand holds the handle. I keep my right index finger pointing along the top of the file; it helps me hold direction. The left hand holds the other end of the file, preferably thumb on top, fingers at the end. But however you hold it, it's practice that counts!

The file cuts on the forward stroke. Apply pressure during the forward stroke first with the left hand, then with the right. On the backward stroke, release the pressure, but keep the file in contact with the work; this helps clean cuttings from the teeth.

The most important part is to keep the file level. The normal tendency seems to be to move the handle up and down as well as back and forth. This rounds off the top of the work which is not usually wanted.

The work should be checked frequently with straight-edge and square; high spots get special attention. The direction of filing can be changed occasionally, going at it from a new direction. The shifting pattern of reflections from the work surface shows where metal is being removed. Remember to clean the file frequently.

As the final surface is approached, shift to a finer file. The finishing touches are put on by "draw-filing." Stand end-on to the work, holding the file like the handle bars on a bicycle, and draw back and forth over the surface. Don't do too much of this, since the middle is cut down faster than the ends, and the work will be hollowed out.

The process of filing usually leaves a "wire-edge" on the edge of the work away from the operator; this can be felt better than seen. It is sharp, so feel across it, not along it. It should be removed by a few final light strokes to put a slight chamfer on the edge.

Too large a file on too small a surface occasionally causes chattering; marks appear on the work duplicating the rows of teeth on the file. Shifting to a smaller file cures this. Sometimes scratches appear on the work pins in the file teeth. Clean the file often.

On large flat surfaces, small files sometimes cut faster than large ones. The large file will cover such an area that you cannot apply sufficient pressure to have all the teeth bite.

Fine finishes can be obtained on small workpieces by reversing the usual process and rubbing the work on a large smooth file resting on the work bench. If you have much of this to do you can adapt a file especially for the purpose by cutting off the tang with a carbide hack-saw blade, and making a shallow box to hold it on the bench.

Filing in the lathe: This is frowned on by purists, but it can be very handy. Special files with a long angle to the rows of teeth are available, but are not really necessary. The file MUST be used with a handle, and your sleeves MUST be rolled up.

The two main jobs are taking the wire-edge off turned corners, and filing a slight taper onto mandrels and the like. The file must be kept in steady motion while it is applied to the revolving workpiece. Use light pressure, and lift the file on the return stroke.

Do not attempt to use the file for more than finishing touches; it is no substitute for the lathe tool. Work "turned" with a file may be smoothly finished, but it will oval in cross-section.

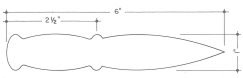
Special Shapes: Rounded corners are filed in the same manner as flat work, except the right wrist is rotated during the forward stroke. Take special care to have the

file square and level, and inspect the work often.

Re-entrant corners are done with a safe edge file. Keep the safe edge against the side not being worked on. You will learn all about it the first time you try it.

Small pieces are often best hand-held, with a small mill or needle file in the other hand. Pressing your forearms against the sides of your body gives added stability. My abdomen happens to be particularly suited as a bench rest!

A Filing Exercise: For practice in filing, try making a set of throwing knives. Hardware stores carry 3' lengths of 1" x 1/8" zinc plated mild steel suitable as stock; cut as many 6" lengths as you want knives. Paint one side of each piece with colored Aero dope or marking out fluid, and scribe this outline on them:



Then file to the line, after removing excess stock with a hacksaw.

Finish each knife by filing the point sharp, (do not sharpen the sides of the blade) and wrap some friction tape around the handle. A suitable target is a cardboard box in the back yard. If you want to throw at a wooden target, the point will have to be case hardened, after sharpening it.

If you have not already written to Mr. E. J. Porter, Simonds Saw & Steel Division, Intervale Road, Fitchburg, Mass. 01420, for a free copy of their "Catalog F-100" and "How to Choose and Use Files," I strongly recommend that you do so. The article on filing is so good that when I read it I was almost discouraged about writing this one. Please mention LIVE STEAM Magazine in your request.

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MORE DATA ON TUBE SIZE

Having read Frank Holland's letter on tube lengths, diameters and boundary layer conditions in the gas flow through tubes of our small locomotive boilers (LS 6/69), I feel that the theoretical and practical aspects should be examined further.

If we consider a tube such as that used in our boilers, a boundary layer begins to form at the entrance and as the gas moves through the first part of a straight tube the layer thickens. During this stage, the boundary layer consists of a core of gas flowing in a rod-like manner at a constant velocity and an annular boundary layer between the wall and the core. In the boundary layer, the velocity increases from zero at the wall to that in the core. As the gas stream moves further down the tube, the boundary layer occupies an increasing portion of the cross section. Finally, at a point well down stream from the entrance, the boundary layer reaches the center of the tube, the rod-like core disappears, and the boundary layer occupies the entire cross section. At this point, the velocity distribution in the tube reaches its final form, and it remains unchanged through the remaining length of the tube. The length of tube necessary for the boundary layer to reach the center of the tube and for the final velocity distribution to be completely established is called the *transition length*.

If the average velocity of the gas is above the critical, the bulk of the stream is in turbulent flow. The laminar sub-layer (next to the wall) and the buffer layer (between the laminar layers and the turbulent core) are permanent characteristics of the flow and persist beyond the transition lengths. The thickness of the laminar and buffer layers are small fractions of the diameter of the tube, and most of the cross section is occupied by gas in fully developed turbulent flow. This complex pattern is called simply *turbulent flow*.

Reynolds, in an extension of his work on laminar and turbulent flow, studied the conditions under which one type of flow changes into the other. He found that the critical velocity, at which laminar flow changes into turbulent flow, depends on four quantities: the diameter of the pipe, the viscosity and density of the gas, and the average linear velocity of the gas. Furthermore, he found that these four factors can be combined into one group, and that the change in type of flow occurs at a definite magnitude of the group. The grouping of variables found by Reynolds was:

$$NRE = \frac{D\bar{V}P}{U} = \frac{D\bar{V}}{V} = \frac{DG}{U}$$

Where D = Dia. of pipe, feet
$\bar{V}$ = Average linear velocity of gas, ft./sec.
U = Viscosity of gas, lb./ft.–sec.
P = Density of gas, lb./ft.^{3}
V = Kinematic viscosity of gas, ft.^{2}/sec.
G = Mass velocity of gas, lb./ft.^{2}–sec.

The group of variables defined by this equation is called the *Reynolds Number*.

Laminar flow is always encountered at Reynolds numbers below 2,100 but laminar flow can persist up to Reynolds numbers of several thousand under special conditions of well-rounded tube entrances and very quiet conditions in the gas flow. Under ordinary conditions of flow, the flow is turbulent at Reynolds numbers above about 4,000. Between 2,100 and 4,000 a transition, or dip, region is found, where the type of flow may be either laminar or turbulent, depending upon the conditions at the entrance of the tube.

From this short excursion into the theoretical aspect of gas flow through straight tubes as used in our boilers, it can be seen that this will require a very careful analysis of conditions which are likely to exist in a boiler; i.e., one has to know velocities, density of gas, temperature gradings, viscosity, etc., in order to arrive at a tube length and diameter which could be considered the optimum attainable. If any of our small locomotive boiler builders were in a position to do these complex calculations and thus arrive at tube lengths and diameters, the sizes arrived at would, in all probability, not be practical due to the length of tube and smallness of diameter.

The practical experience gained over many years has a lot to commend itself when choosing tube diameters and length, with some regard to the type of coal being fired.

Tube diameters smaller than 3/8 inside are not a proposition, due to the blocking which occurs at the firebox end, with small clinkers, flakes of ash, which quickly affects the steaming adversely. For the average size locomotive, 3½" and 5" gauge, tube diameters of 7/16ths O.D. x S.W.G. and ½" O.D. x 20 S.W.G. giving an inside diameter of 3/8 and 7/16ths respectively should be considered. If bituminous coal is used, then the number of tubes should be

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reduced slightly in order to maintain a higher gas velocity, which will to some extent minimize the fouling factor encountered with this type of coal, which has a high content of volatile matter. In my opinion it is unnecessary to fire intermittently coal, other than for the visible smoke effects created, and the owner therefore has to accept the attendant problem of bi-hourly cleaning. Anthracite of a calorific value of between twelve and fourteen thousand BTU's per lb. being readily available, there is no reason to use bituminous coal with a calorific value of around ten thousand, other than for the effects mentioned. Tube lengths of 8" to 14" long should be used for the tube diameters given, if the tube length of 14 inches is exceeded than a combustion chamber should be considered if the boiler has the ability – as a combustion chamber takes very careful making if a lot of heartbreaks are to be avoided.

My reasons for using a combustion chamber are simple; as the temperature difference decreases as the gas passes through the length of the tube, the longer the tube the more likelihood of the dew point of the volatiles in the gas being reached – thus causing extensive fouling in the last third of the tube. This in effect means that by the use of a combustion chamber, the last third of the tube is transferred into the smokebox where the loss of heat transfer due to fouling is of no consequence and thereby maintaining as much as possible the use of the radiant heat of the firebox.

Experience has shown that my own two locomotives (which are fitted with combustion chambers) are very east steamers indeed. This is over a long period with good and bad coal, especially useful when doing heavy passenger hauling over long periods when a free steaming boiler becomes a real pleasure to the owner.

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